

The Image Guided Therapy (IGT) Room of the Future

W. KUCHARCZYK, MD, FRCPC

In modern medicine, imaging is now indispensable for the detection and diagnosis of disease, the monitoring of disease progression and treatment response, and more and more so, the guidance of the treatment – during the actual treatment. The development of faster and faster image acquisition methods and image reconstruction algorithms, the ability to fuse and display information from different imaging sources into multi-parametric 3D image datasets, the ability to anatomically register these incredibly data-rich images to the patient's frame of reference, together with on-going inventions of novel, minimally invasive, image-guided treatment devices, has logically led to efforts to design and build the ideal Image-Guided Treatment (IGT) room – a room where these technologies, alone or in one or more combinations, can be best applied for optimal patient treatment – during the treatment. With the growing importance of image-guided therapy, IGT rooms are increasing in prevalence. There are many variations in their design or contents. There is no consensus as to which imaging modalities should be included in IGT rooms, or how they should be configured in relationship to one another, or even where such a room should be located within the hospital. If surgeons lead the IGT development effort, their plans often lead to IGT room locations adjacent to other surgical suites. If radiologists lead the design team, a location in the neuroradiology or “interventional radiology” division is more likely. Neither approach is best; ideally all stakeholders in the hospital should join together to choose a location and design that is optimal for the types of treatments that will be done in the room, and what is best for patient and the hospital.

The most basic IGT room contains a patient couch and a C-arm and/or ultrasound. In this sense, all operating rooms and interventional radiology rooms are IGT rooms. However in this editorial, the term “IGT room” is not used in this context. IGT is meant to refer to rooms that have more than the basics, and where image guidance is the essential element in treat-

ment decisions. Over the past two decades, the imaging modalities that have been installed into IGT rooms have included CT, angiography, and MRI. In the near future, PET, and optical imaging will be included in some rooms in some hospitals. Robotic instrument manipulators, and minimally invasive treatment devices such as RF and laser ablation probes, and MRI-guided high intensity focused ultrasound will be more frequently used in such rooms.

Increasingly with the most recent installations, and in the design of future installations, these diverse systems are installed together to permit multi-modal imaging. Multi-modal imaging guides therapy using comprehensive information derived from the different physical and biological characteristics of the tissues in ways that a single imaging modality cannot, compensating for any weakness of any individual modality. Multi-parametric image information is displayed integrated within complex therapy delivery systems.

The design of a hospital's future IGT room should very much be driven by the types of treatments that are planned for the room. If complex neurovascular surgery is to be combined with endovascular neuroradiology, the most important elements for IGT would likely be a bi-plane neuroangiography system co-located in a neurosurgical operating suite. CT and/or MRI could be added to the same IGT suite but are not as critical as the angiography system. If skull base surgery is to be a focus, angiography assumes lesser importance (and may be unnecessary) whereas CT and MRI become more critical. PET has rarely been co-located in such facilities, but could be considered if molecular medicine research was an important focus of the institution. An integrated navigation system with the ability to fuse data from all imaging sources, and display this information in the frame of reference of the patient is equally important.

In the design of the future IGT room, the design of the patient treatment couch and the patient transport system are as crucial as any of

pieces of imaging equipment. An integrated patient transfer system, monitoring, and anesthesia delivery equipment are critical. It is essential that the patient couch be able to move safely and quickly between the different nodes in the IGT suite, recognizing that some of the modalities bring with them unique safety challenges and hazards, as for example the magnetic field with MRI.

Patient transfer speed and imaging speed are also important. The use of the IGT room must not add hours to the procedure. IGT should achieve higher treatment accuracy and greater certainty of complete treatment, with less patient morbidity, but this must not be at a penalty of very long procedures – otherwise the future IGT room will prove to be a very costly project that is rarely used. With proper design and planning, patient transfers between the various imaging and treatment nodes in the IGT room can be achieved on the order of 2-3 minutes using a combination of pivoting and translating the patient couch, and doing the same with the imaging equipment, mounted on either floor or ceiling rails. Each of the major medical imaging vendors have implemented, or are implementing, their own solutions to these issues.

I think the main elements of the future IGT room will center around a fully equipped operating room with a highly integrated navigational system and with a highly customized patient couch. The table will be able to pivot 90 degrees into a bi-plane angiography system, 90 degrees in the other direction into a high speed dual energy CT scanner, or translate on rails into a wide-bore MRI scanner. With so much expensive equipment, obviously such an IGT suite would be hugely expensive, and therefore should not be widely installed. My view is that for the near future at least, such a comprehensive IGT room should only be installed in large quaternary hospitals that have a large complex-care patient population, and multi-disciplinary collaborative teams dedicated to translational clinical research. It would be medically unnecessary and fiscally irresponsible to use this type of IGT suite for routine cases. The resource should be concentrated into a limited number of places. Hence the recommendation to install only in quaternary care hospitals, where there will be higher likelihood of having subsets of the patient population that would benefit from being treated in a suite where all imaging modalities are available during their treatment.